Quantitative Portfolio Theory & Performance Analysis

Week of April 29th, 2013
Evaluating the Investment Management Process & Decomposing Performance

Assignment

- For April 29 (This Week)
  - Read: A&L Chapter 7
  - Read: E&G Chapter 25&27

- Last Day of Class: Wednesday, May 1st
- Final Project Presentation: Monday, May 13th; 9:00am – Noon (Whitehead 203)

Constructing a Portfolio

- Steps in Constructing a Portfolio
  - Asset Allocation
    - Strategic Allocation – corresponds to investor’s objectives and constraints
    - Managing the Strategic Proportions
      - Dynamic Allocation
      - Market Timing & Tactical Allocation
  - Stock Picking

- Strategic Allocation
  - The initial PF that corresponds to the investor’s objectives and constraints
  - These decisions correspond in reality to the choice of a benchmark (PF)
  - The choice is based on the risk and return estimations for the asset classes – carried out quantitatively
  - The Markowitz model applied to asset allocation
  - The most widely quoted quantitative model in the strategic allocation literature
  - Input data: means & variances of the returns for each asset class, plus correlations between assets
Constructing a Portfolio

- Strategic Allocation
  - The Markowitz model applied to asset allocation
    - The model provides percentages in each asset class to provide the best return for a given level of risk
    - Even though the most widely quoted, it is not in fact very widely used in practice
      - Results are very sensitive to mean return values
      - Mean returns are very difficult to estimate statistically
      - Several “fixes” proposed
      - Uses variance as a risk measure – may be better to use VaR
    - One technique to solve problem of mean returns is to use Bayesian techniques – investor forecasts

- Alternative models to Markowitz’s optimization
  - Treynor & Black’s model optimize through determining return sources of risk and calculating exposure to each
  - Black & Litterman refine this by introducing uncertainty about the model parameters
  - Scherer describes how to use alternative risk measures
    - LP approach to minimizing Mean Absolute Deviation (MAD)
    - LP approach to minimizing maximum PF loss
    - Minimize CVaR using LP
  - Sharpe asset allocation model – a multi-factor decomposition based on historical returns

Constructing a Portfolio

- Managing Proportions
  - Several Principles are used
    - Keep the structure found from strategic allocation
    - Establish a procedure for readjusting with market
      - Portfolio Insurance (like dynamic hedging)
    - Readjust allocations to take into account (advantage of) short term forecasts of market movements and evolution of the economic environment
      - This approach is highly dependant on data reliability & forecasts
      - Asset class returns are somewhat predictable; though there is little evidence of the predictability of specific component of returns in the absence of private information

- Market Timing & Tactical Allocation
  - A consequence of predictability of asset returns
  - Usually as a result of observing market indicators
    - Which allow the manager to take advantage of temporary inefficiencies which often result
  - Success of tactical allocation depends on the quality of the forecasts; two approaches
    - Fact-based: only uses currently available information, like interest rates
    - Forecast-based: uses forecasts of the future, like anticipated growth rate
  - Fact-based approaches have a larger following
Constructing a Portfolio

- Managing Proportions
  - Market Timing & Tactical Allocation
    - A widely used technique is to use risk premiums
      - For stocks, bonds and bills, for example
      - If the expected return of stocks over bonds is above the mean value for that category, then choose to over-weight stocks
    - Of course, determination of the expected returns can be a challenge; for stocks, many use the dividend discount model (DDM) or something such as Graham-Dodd
    - For stocks and bonds, an adjustment for inflation may also be incorporated to make comparisons to short term rates appropriate – term premium

Performance Decomposition & Analysis

- Identification of Sources of PF Performance
- Fama’s Decomposition
  - Relies on CAPM as it compares the managed PF with two theoretical PFs on the market line
  - The study PF, $P$, has total risk $\sigma_P$ and systematic risk $\beta_P$
  - Assume the PF is not on the market line
  - Compare performance with two PFs on the market line
    - $P_1$: the PF with beta equal to the beta of $P$, $\beta_{P_1} = \beta_P$, so
      $E(R_{P_1}) = E(R_p) + \beta_P (E(R_m) - E(R_p))$
    - $P_2$: the PF with a beta equal to the total risk of $P$, $\beta_{P_2} = \sigma_P$, so
      $E(R_{P_2}) = E(R_p) + \sigma_P (E(R_m) - E(R_p))$
Performance Decomposition & Analysis

- Fama’s Decomposition

1.13

Performance Decomposition & Analysis

- Fama’s Decomposition

1.14

Performance Decomposition & Analysis

- Fama’s Decomposition

1.15

Performance Decomposition & Analysis

- Fama’s Decomposition

1.16
Fama’s Decomposition
- Portfolios P and P₁ have the same beta, the same non-diversifiable risk, but not the same total risk
- All the risk from the naïve strategy – risk-free investment plus the market PF – comes from fluctuations in the market PF
- Thus the risk of the benchmark is non-diversifiable
- However, the study PF is not a market PF or its return would lie on the market line; in the process of earning extra return, the study PF takes on diversifiable risk
- Is the extra return worth the extra risk
- That is where the second benchmark P₂ comes in
- \( E(R_\text{f}) - E(R_p) \) is the return deviation with that extra, diversifiable risk; positive, it was worth it for the manager to exercise selection

The risk term is broken down into the manager risk and the investor risk
- So we define a 3rd PF \( P_0 \) with systematic risk \( \beta_0 \) corresponding to the investor’s desired level of risk
- The manager can take a risk \( \beta_\text{p} \) different from \( \beta_0 \), based on his forecasts of how he thinks the market will evolve and can be adjusted regularly (a timing strategy)
- The decomposition of the risk term is then written as:
  \[ E(R_\text{f}) - E(R_p) = E(R_\text{f}) - E(R_\text{p}) + \{E(R_\text{p}) - E(R_\text{f})\} \]
- The 1st term is the manager risk
- The second term is the investor’s risk
Performance Decomposition & Analysis

- Decomposition & Investment Stages
  - Inspired by Fama’s principle of performance decomposition
    - Distinguish between choice of BM, which characterizes the risk taken, and the choice of assets
  - Models that decompose according to IM stages also use this principle (Brinson et al. (1986))
    - This type of model allows analysis where there are several asset classes – effects are then summed
  - “Asset classes” should be broadly defined
    - Though the following considers stocks & bonds
    - Within: sector, credit, capitalization, industry, etc.

1.22

Performance Decomposition & Analysis

- Decomposition & Investment Stages
  - Brinson et al. Model
    - Three stages of the IM process – strategic allocation (policy); tactical allocation or timing; and stock picking
    - The method has three phases
      - 1st: BM PF w/ weightings corresponding to long-term allocation
      - 2nd: Successively consider a PF that combines strategic allocation with one or the other components of return – market timing and stock picking
        - Market timing component: calculated by considering the BM return, but by taking the real asset allocation
        - Stock picking component: consider real returns of asset classes, but with BM weightings

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Performance Decomposition & Analysis

- Decomposition & Investment Stages
  - Brinson et al. Model
    - 3rd and Final phase: Calculates the overall PF return from the return components
    - For each asset class components real to BM

Written formally as:

- Selection Effect
  - Real Portfolio
    - (IV) \( \sum_{i} w_{i} \pi_{i} \)
  - Passive Portfolio
    - (II) \( \sum_{i} \pi_{i} \) \( \sum_{i} w_{i} \pi_{i} \)

- Timing Effect
  - Real Portfolio
    - (III) \( \sum_{i} \pi_{i} \)
  - Passive Portfolio
    - (I) \( \sum_{i} \pi_{i} \) \( \sum_{i} w_{i} \pi_{i} \)
**Performance Decomposition & Analysis**

- **Decomposition & Investment Stages**
  - Brinson et al. Model
    - Using this decomposition calculate the manager’s active contribution at each stage of IM process
      - As difference between the term that measures the effect in the PF and the term that measures the effect in the BM

  1. Active return due to the timing or tactical allocation: (II) - (I) or
     \[ \sum (w_i - w_k)(R_i - R_k) \]
  2. Active return due to stock picking: (III) – (I) or
     \[ \sum w_k (R_i - R_k) \]
  3. Interaction between allocation and stock picking: (IV) – (III) – (II) + (I) or
     \[ \sum (w_i - w_k)(R_i - R_k) \]

**Performance Decomposition & Analysis**

- **Decomposition & Investment Stages**
  - Brinson et al. Model
    - To carry out the study it is necessary to know all the movements that have taken place; and the sub-periods where the PF was fixed
      - The more frequent the fluctuations the more sub periods

  - **Contribution of Asset Allocation**
    - Given by the difference in the sector weighting in the PF vs. BM multiplied by the out-performance of sector compared to overall BM
      \[ (w_i - w_k)(R_i - R_k) \]

  4. Overall active return corresponds to difference (IV) – (I) or
     \[ \sum w_i R_i - \sum w_i R_k = \sum (w_i - w_k)R_i + \sum w_k (R_i - R_k) + \sum (w_i - w_k)(R_i - R_k) \]
      - The excess PF return is divided into a term that comes from an allocation between the asset classes that is different from that of the BM, which corresponds to a different level of risk;
      - A term that comes from stock picking, which is different from that of the BM within each asset class;
      - And a final term which represents the interaction between the two

**Performance Decomposition & Analysis**

- **Decomposition & Investment Stages**
  - Brinson et al. Model
    - **Contribution of Stock Picking**
      - Difference between the return on the asset sector in the PF vs. BM, multiplied by the weighting of the sector in the BM
        \[ w_k (R_i - R_k) \]
    - **Contribution of Interaction**
      - Is the product of the difference in the weightings and the returns, BM vs. PF
        \[ (w_i - w_k)(R_i - R_k) \]